DOCUMENT RESUME

ED 143 620 95 SP 011 279

AUTHOR Gow, Doris T.
TITLE A Synthesis of Research in Basic Skills.
INSTITUTION Pittsburgh Univ., Pa. Learning Research and Development Center.
SPONS AGENCY National Inst. of Education (DHEW), Washington, D.C.
PUB DATE May 77
NOTE 69p.; Best copy available

EDRS PRICE MF-$0.83 HC-$3.50 Plus Postage.
DESCRIPTORS *Basic Reading; *Basic Skills; *Educational Research; *Elementary Education; *Elementary School Mathematics; Instructional Improvement; Interaction Process Analysis; Needs Assessment; *Performance Factors; Skill Development; Student Characteristics
IDENTIFIERS *Pennsylvania School Improvement Program

ABSTRACT

In this monograph research results of studies on the teaching of basic skills in elementary schools is synthesized with emphasis on the practical implications for actual practice in the classroom. Development of skills in reading and mathematics in the early grades is the focus. Four major factors in basic instruction are discussed. The importance of opportunity for study and time allowances for concentration on each subject is one of these factors. Motivation of students, positive reinforcement, and classroom atmosphere are considered important forces in the learning process. Organization and sequencing of instruction and planning of curriculum are also major factors discussed. Interaction between teacher and students and individual characteristics of all classroom participants is the fourth primary area covered. Results of research in each of the above categories (opportunity, motivators, structure, and instructional events) are outlined and analyzed. Three tables that might be used in program analysis or selection are appended. One is taxonomy of reading comprehension, one lists bases for evaluation of readers and related materials, and the third analyzes 13 reading programs in terms of selected variables. A report of the working group on goals for basic mathematical skills and learning is also appended. A bibliography of reading materials on research in basic skills is included. (JD)

**********
* Documents acquired by ERIC include many informal unpublished *
* materials not available from other sources. ERIC makes every effort *
* to obtain the best copy available. Nevertheless, items of marginal *
* reproducibility are often encountered and this affects the quality *
* of the microfiche and hardcopy reproductions ERIC makes available *
* via the ERIC Document Reproduction Service (EDRS). EDRS is not *
* responsible for the quality of the original document. Reproductions *
* supplied by EDRS are the best that can be made from the original. *
**********

ED143620

U.S. DEPARTMENT OF HEALTH
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

# A SYNTHESIS OF RESEARCH IN BASIC SKILLS

Doris T. Gow

BEST COPY AVAILABLE

Pennsylvania
School
Improvement
Program

Learning Research and Development Center
University of Pittsburgh

SP011 279

# A SYNTHESIS OF RESEARCH IN BASIC SKILLS

Doris T. Gow

Learning Research and Development Center

May, 1977

This Synthesis was written for the Pennsylvania School Improvement Program, supported by funds from The National Institute of Education (NIE), United States Department of Health, Education, and Welfare. The opinions expressed do not necessarily reflect the position or policy of NIE, and no official endorsement should be inferred.

Table of Contents


| | Page(s) |
|---|---|
| Introduction. . . . . | 1 |
| The Research in Basic Skills. . . . . | 4 |
| Opportunity. . . . . | 4 |
| Motivators . . . . . | 7 |
| Structure. . . . . | 11 |
| Instructional Events . . . . . | 13 |
| Implications for Practice . . . . . | 18 |
| Recommendations of the Experts. . . . . | 23 |
| Student and Teacher Characteristics . . . . . | 27 |
| Student Characteristics. . . . . | 27 |
| Teacher Characteristics. . . . . | 32 |
| Conclusion. . . . . | 35 |
| Bibliography . . . . . | 39-48 |
| Table 1 . . . . . | 49 |
| Table 2 . . . . . | 50-51 |
| Appendix 1 . . . . . | 52-54 |
| Appendix 2 . . . . . | 55-57 |
| Appendix 3 . . . . . | 58-59 |
| Appendix 4 . . . . . | 60-64 |

# INTRODUCTION

## The Purpose

Why would the Pennsylvania School Improvement Program undertake a literature search in basic skills?

Designed to improve instruction in basic skills in Pennsylvania's schools by assisting the schools in identifying their needs and then selecting, installing and implementing R & D outcomes to meet those needs, the program's efforts seem to be concentrated at the dissemination and implementation end of the continuum from theory and basic research to practice. This synthesis of the research, however, reflects a more fundamental implicit purpose of the program, which is more than to service schools by helping them identify their needs and then informing them about available R & D outcomes which might meet those needs. This purpose is to develop and establish a more rational procedure than has been used up to now for decision-making by educators. It is not enough that the programs or practices they may select are R & D outcomes, presumably with solid theoretical underpinnings. It is desirable that procedures be developed which help practitioners to make wise choices for themselves based on as much relevant information as possible which they can assemble or the R & D agencies can supply.

If research and development are to have maximal impact on practice, the researcher must interact with schools and information must flow freely between the researcher and the schools at every stage of the instructional process from identification of needs to implementation of an appropriate program or practice. R & D/educator interaction has indeed taken place through the use of developmental and field test schools. However, this is a highly specific

and limited relationship based on one or more products or processes. The scope of the PSIP is not limited to a single piece of research or a single product or process. The network links R & D agencies with the schools through the state and intermediate agencies. This makes possible a continuing cooperative relationship and information exchange which can help to narrow the gap between theory and practice. One phase of that information exchange process is this synthesis of the literature on basic skills research. So that the procedure can be improved on the basis of the initial experience, the process is described briefly as well as the results.

The Sources and Procedures

Research, by its very nature, is seldom definitive. There are always new studies, new perspectives on old studies, replications and failures to replicate. The vast amount of research in the basic skills, and the contradictory nature of much of it, makes a synthesis of this kind a precarious undertaking. The experts in reading and math do not agree among themselves about methods.

This study began, typically, with a computer printout several inches thick which proved to be relatively unproductive for the time expended on it. Reports of the less well-known research often could not readily be evaluated and results were ambiguous. Major national research studies, syntheses of research, and conferences of researchers, often sponsored by USOE or NIE, were the most productive sources of reliable data and conclusions which could provide practical guidance for practitioners. These included the First Grade Reading Instruction Programs Report, 1967; The Beginning Teacher Evaluation Study, 1976; The Follow-Through Studies, 1970-73; The Learning

Research and Development Center Reading Conferences, 1976; The Craft Studies, 1968; The NIE Conference on Basic Mathematics Skills and Learning, 1975; The Texas Teacher Effectiveness Study, 1974, and others.

Information was collected and organized under four constructs of the Cooley-Lohnes Model of classroom processes (i.e., opportunity, motivators, structure and instructional events) supplemented by the categories, student and teacher characteristics, which seemed particularly relevant to the PSIP. The construct, instructional events, in the Cooley-Lohnes Model refers to interpersonal classroom interactions. As used for organization of data for this study, the construct is expanded to include instructional strategies and instructional methods. Structure, in this study, includes the classroom management system.

The Cooley-Lohnes Model seemed an appropriate vehicle for collection and organization of data because the categories of the model are components of classroom practices which may be collected through questionnaires and observation during the needs assessment phase of PSIP activities and which may also be identified in instructional materials through analysis in the program analysis and outcomes selection phases. Selection of this model for the organization of the literature search, therefore, made possible consistency in the organization of information in all phases of PSIP research.

## THE RESEARCH IN BASIC SKILLS

### Opportunity

The research on the importance of opportunity to student achievement is impressive. John Carroll (1963) and Benjamin Bloom (1974) have written persuasively about the effect of time on student learning. Barak Rosenshine (1976) reports on an International Educational Association Science Study which shows support for the importance of opportunity. Emphases on learning of content (opportunity through content covered) showed significant relationship with student achievement in studies by Armento, 1975; Chang & Raths, 1971; Rosenshine, 1968; and Shutes, 1969.

There is a marked tendency for less successful reading projects to be associated with a shorter school day (Bond & Dykstra, 1967, p. 196) and students whose attendance is regular achieve somewhat better than those whose attendance is less regular (Bond & Dykstra, 1967, p. 54). Days of student absence and days of teacher absence are usually negatively correlated with achievement (Rosenshine, 1971).

In their study of Detroit metropolitan area schools, Wiley and Harnischfeger (1974) found that the average number of hours of schooling provided in a particular school, computed from average daily attendance, length of school day, and length of school year, was positively related to achievement in verbal ability, reading comprehension and mathematics.

Decker F. Walker and Jon Schaffarzick (1974) reported that time spent on content or dimension (e.g., math or reading) is associated with growth in these areas. A survey relating math achievement to time spent in learning was conducted by the International Education Association (IEA). It showed, as did

several earlier surveys, that opportunity to learn the subject (time actively engaged) has been important (Phillips, 1976). Cooley and Leinhardt (1974) found that class means tended to be higher if teachers allotted more time to mathematics each day.

The important study of Stallings and Kaskowitz (1974) indicates that academic time spent on reading and numbers yields growth, while time spent on other areas (arts, crafts, games, etc.) detracts from growth in reading and math (see Table 1). Additionally, there is no indirect enhancement effect on reading and math from these other activities. This study concludes that the stronger the academic emphasis the stronger the academic results (p. 35). Time spent on mathematics or reading and time spent on academic tests yielded positive, significant, and consistent correlations of about, .40 with achievement in Follow-Through classrooms. Rosenshine concluded that content covered, opportunity to learn and teacher emphasis on student achievement are important variables in achievement in math and reading (1976).

Wiley and Harnischfeger, controlling for economic status, found that in schools where children receive 24% more schooling, they will increase their average gain in reading by 2/3 (1975).

In grade 2 compensatory reading programs, amount of time had a significant effect on the word knowledge subtest of the MAT. For high skill emphasis programs at this grade level, amount of instructional time did not affect comprehension but in programs with low skill emphasis amount of instructional time had a distinct impact.

In sixth grade more instructional time benefited low SES children in both word recognition and comprehension. In contrast, increasing amounts of

time did not benefit middle socioeconomic groups and had inconsistent impact on high SES children at this grade level (Guthrie, in press).

The amount of time devoted to reading activities correlates .56 with achievement in word recognition and .55 with achievement in comprehension for first grade children, Harris and Serwer of the CRAFT Project report. Reading activities, in this study, included work in basal readers, experience charts, sight word drill and phonics activities. Supportive activities such as writing, art, discussion and dramatization did not correlate significantly with achievement. "Apparently, instruction must be targeted to reading related activities if it is to influence reading achievement" (Guthrie, in press).

Time spent on workbook exercises or on individually prescribed learning activities has been found to be positively related to achievement for low socioeconomic classes, whereas time spent on oral responding is negatively related. For high socioeconomic classes, time spent on oral responding is most productive (Brophy & Evertson, 1974).

Project LONGSTEP's Final Report indicated that:

> Students who exhibited unusually large gains in reading achievement during two consecutive school years were exposed to much more language arts instruction as second graders than were students with a notable lack of growth (i.e., 113 minutes per day compared with 85 minutes). The consistent overachievers, as third graders, were exposed to about 20 minutes of instruction per day less than during the previous school year, and yet they again demonstrated larger than expected gains in achievement. These results suggest that increased exposure to language arts during the second grade may significantly improve the chances of some students to demonstrate substantial gains in reading achievement, even in later grades. (Project LONGSTEP, 1976).

There appears to be little doubt that opportunity to learn is an extremely important factor in student achievement in basic skills. Opportunity is

figured variously in the studies supporting this construct on the basis of length of school day, year, regularity of attendance (days of student absence), days of teacher absence, time actively engaged in learning, content covered, and academic emphasis (time on non-cognitive activities detracts from achievement in these areas). Opportunity is reported to affect verbal ability, word recognition, reading comprehension and mathematics achievement. The importance of opportunity apparently varies according to grade level, with strong effects in early elementary grades. It is important to point out that the constructs used in this report are interdependent. Some of the research on opportunity points to differential effects for different kinds of instructional events (seat work and oral responding) depending on the characteristics of the students.

## Motivators

Another construct of the Cooley-Lohnes Model (1976) is motivators, both internal and external. Cooley and Leinhardt have explained the construct in this way:

> By internal motivation, we mean those sets of student behaviors and attitudes that tend to support high rates of learning activity.
>
> By external motivators, we mean those elements that can be built into an educational environment to increase the likelihood of an individual engaging in and sustaining learning activities. (1975).

Among the variables the Cooley-Leinhardt publication suggests for measuring this construct are curricular attractiveness, curricular diversity and interpersonal contacts. We have elected to organize under the construct the research in basic skills which refers specifically to motivating elements of

programs or practices, or combinations of elements which, taken together, create a motivating climate.

One motivator that might not be available for use in many schools is computer assisted instruction in beginning reading (CAI). Fletcher (in press) reports that students obviously enjoy it. Recommended for use in a supplemental role, the Stanford Project reported an increase in student achievement. The program was also highly structured as well as motivating, with a heavy decoding emphasis and small step, carefully sequenced objectives. Even though the emphasis was on decoding, rather than comprehension, beginning students scored significantly higher on the paragraph meaning subtest of the Stanford Achievement Test than a non-CAI control group.

S. J. Samuels, (in press) a discussant at the LRDC Reading Conference, reported on Weber's findings that strong leadership, high expectations for students, positive reinforcement, an orderly, pleasant, happy atmosphere, strong emphasis on reading, use of additional personnel, use of phonics, individualization, and careful day-to-day evaluation of pupil progress contributed strongly to success of reading programs in his New York State study. All of these elements would qualify as motivators. Together they create a motivating climate. The reading emphasis and high expectations for students can contribute to creating a school where reading is "the thing to do." Gordon (in press) noted that is some schools this is the case, in others, a student would "not be caught dead reading." This, he said, is important.

S. J. Samuels also found that girls are significantly more attentive in class and also read better. He suggested that it may well be the attentiveness rather than a genetic factor that is related to the better performance (Samuels & Tunure, 1974).

Frank Smith, of the Ontario Institute for Studies in Education, reports that children are motivated to learn to read when they learn the function of reading, just as they learn to talk to "express feelings, explore ideas, ask questions, obtain answers, manipulate others, assert themselves and establish and maintain specific interpersonal relations" (in press). The functional approach to reading, he has found, is motivating because the student sees the utility of learning to read.

The Goodmans (in press) also believe that it is through relevant use of language that children learn it. The effective strategies for teaching reading, based on this motivational approach, they report, include the following:

1. play stores, reading cans, supply orders (I want)
2. signs, directions, rules (Do as I tell You).
3. notes on message board, post offices, games (Me and You).
4. books about self, family, pictures and captions, experiences, stories with characters to identify with (Here I come).
5. question box, instructions to make things, recipes, (Tell my why).
6. story telling, acting out stories read, copying down creative dramatics, read along books and records (Let's pretend).
7. bulletin boards, notes to pupils, class newspaper, weather board (Something to tell You).

This language experience recommendation seems to contradict some of the research on structure and on the negative correlation between time spent on non-academic activities and achievement. Motivationally, however, this recommendation may be appropriate.

The Stallings and Kaskowitz study (1974), which was one that yielded results seeming to conflict with this language experience stance, found that

puzzles, games, toys, arts and crafts and active play are negatively correlated with achievement. This would appear to emphasize the strength of the opportunity construct and to suggest that choice of motivators should be made carefully in an attempt to select activities that yield cognitive results. The language function activities suggested by the Goodmans are designed to provide practice in the functional use of language, which is somewhat different from clearly non-academic game-like motivators. The negative correlation with achievement was not with game-like activities that had been explicitly designed to teach.

Both the Scar (1973) and Stallings and Kaskowitz (1974) studies found support, particularly in third grade, for children working in a large group with the teacher providing intensive instruction through direct academic questions which maintained attention and motivation.

Amount of reinforcement, also is related to level of motivation. Too few reinforcers cause the students to stop paying attention, and reinforcement affects student performance and retention (Berliner & Gage, 1976).

Motivation may be related to student goals, as well. Robert Davis has pointed out that a clearcut career identification seems to provide motivation for mathematics even if the goal is the later changed (1974).

To summarize, then, motivators, the research suggests, include the following: a school environment which provides strong leadership; high expectations for students; positive reinforcement; an orderly, pleasant, happy atmosphere; strong emphasis on reading; use of additional personnel; use of phonics; individualization; careful day-to-day evaluation of pupil progress; and a climate which makes reading the accepted thing for students to do.

Activities in reading and language arts should make students aware of the function of language and encourage them to use (practice) it, and future career goals can be motivators for math achievement. Also, large group intensive instruction with direct academic questions is motivating, as is computer assisted instruction. Finally, student attention may be maintained by provision of sufficient reinforcement, which affects both performance and retention.

## Structure

The structure construct deals with organization and sequencing of instruction, specificity of objectives, and match of student and curriculum. For an appropriate match, the testing or other placement procedures (or self-placement) are important elements of structure. Match of test items to objectives is another variable to consider under this construct.

The research results of some of the major studies would delight the structure of the discipline reformers of the sixties and the instructional designers who employ hierarchy construction procedures (Bruner, 1960, 1966; Ausubel, 1964; Elam, 1964; Gagne, 1965; Resnick, 1972; Briggs, 1970; Gow, 1973; 1977, in press). Many of the major research studies in basic skills have found positive correlations between the degree of structure in the program of instruction and achievement in reading and math.

In their comprehensive first grade reading instruction study, Bond and Dykstra reported that among the five top rated projects (out of 27), 81% of the teachers were rated by their supervisors as having well-organized classrooms and highly structured ones, while only 22% were so rated among the 5 lowest.

A cost effectiveness study prepared for the Michigan Department of Education (1976) compared 50 unsuccessful compensatory education programs with 42 unsuccessful ones. Here again, degree of program organization was found to affect reading results. (See, also the attached summative table (Table 1) on the Stallings and Kaskowitz study of Follow-Through Classrooms which found that time structured by the teacher is positively correlated with achievement).

Of course these studies attend to gains in basic skills achievement. It may be that self-management skills are more highly valued in some schools and teacher control and structuring to improve basic skills achievement are less valued. Some of the information from the self-scheduling system at the LRDC would support systematic training in self-scheduling even in primary grades. This program, however, is a very highly pre-structured one even though the child, rather than the teacher, schedules his/her own activities from a carefully structured array.

Among the common characteristics of successful compensatory education programs identified in an Office of Education report on Programs that work was clarity of objectives, careful sequencing, flexibility of grouping on the basis of individual problems (frequently one-to-one) and a structured program approach (1974).

That the experts assembled at national conferences on reading and math recognized the critical importance of program organization, is apparent from the number of participants who attempted to outline optimal sequences, or who debated over the most effective steps in the teaching of beginning reading or the appropriate order in which to introduce mathematical concepts (Resnick & Weaver, in press; NIE Conference on Basic Mathematical Skills and Learning, 1975).

As we pointed out previously, the constructs used to organize this research are interdependent. This becomes especially clear when considering individualization of instruction, an instructional method which could be organized under "instructional events" in terms of the one-to-one teacher-student interaction, but could be considered "structure" because the individualization process often uses a structured curriculum model to operate effectively in a classroom. It could be designated "opportunity" because the child working alone and independently could spend more concentrated time on task. It could be a "motivator" since individualized attention is motivating. An interesting construct used to describe some of the overlapping characteristics, which apparently are powerful taken separately or together in describing instructional environments, is "intensity of treatment" (Compensatory Programs Report, 1974).

## Instructional Events

Cooley and Leinhardt describe instructional events as the "content, frequency, quality, and duration of instructional interactions" and specify that "it refers primarily to an interpersonal contact, either between a student and a teacher or among students" (1975, p. 6). It is used here in a much broader sense to mean all instructional events including those tasks specified in instructional materials for the student to perform, as well as teacher-pupil instruction. It includes research on instructional methods and instructional strategies.

Attention to individual student needs is one important element affecting the quality of instructional events. Another element is encouragement of participation in class.

Sixty five percent of teachers in the five high ranking projects and only fifteen percent of teachers in the five low ranking projects in the USOE first grade reading study exhibited awareness of and attention to individual student needs, while 1/3 of the low rated teachers displayed total lack of awareness of needs of pupils being taught. In addition, 70% of teachers in the five high and 23% of teachers in the five low projects encouraged class participation by pupils (Bond & Dykstra, 1967, p. 196).

How the teacher questions students has an effect on student achievement, also. Convergent, drill or single answer questions correlated significantly with achievement in a study by Stallings and Kaskowitz of Follow-Through Classrooms (Table 1), while divergent, open-ended questions correlated negatively (Rosenshine, 1976, p. 355). This seems consistent with the previous findings about time and structure. Single answer questions amount to practice or drill and could be labeled "intensity of treatment."

Feedback and correction are needed by the student. He must know if he makes an error and must be told why he made it and how he can correct it. (Carroll & Chall, 1975). Provision of academic feedback correlates with achievement. The nature of the feedback differs, however, for different students. For low socioeconomic students the best feedback to a correct answer is a new question: for an incorrect answer, it is the correct answer. For high socioeconomic students, the best feedback for a correct answer is process feedback, asking how it was found: for a partly correct answer, the teacher should give the answer: for a wrong answer, she should criticize (Rosenshine, 1976).

Non-curricula interactions are negatively related to achievement in high socioeconomic classrooms including frequency of teacher questions about self,

procedural rather than substantive contacts, student initiated contacts about personal concerns. Negative, but nonsignificant correlations for these contacts were found for low socioeconomic status classrooms (Brophy & Evertson, 1974). This, of course, is consistent with the previously cited findings on non-academic activities and their negative correlation with achievement (see Table 1).

With all kinds of interactions between student and teacher the attitudinal characteristics of the interaction are important. Teachers of high achieving classes accept, clarify and use student ideas significantly more; and encourage significantly more student-initiated talk than teachers of low achieving classes (Amidon & Giammatteo, 1965). Irritation, tension, group conflict and aggression are produced under autocratic leadership (Lewin, Lippett, & White, 1939), and Cooley and Leinhardt found a negative relationship between the percentage of negative teacher contacts and student achievement (1974).

Individual attention from the teacher is needed by every student. Project LONGSTEP reports that the most important determinant of a pupil's achievement, found in the study of the impact of educational innovation on student performance, was the amount of individual attention given to the student by the teacher (1976).

Researchers in mathematics have found that the frequency of the use of logic by the teacher was identified as a significant variable in children's acquisition of logic, and it was pointed out by Gregory and Osborne (1975) that the ability to use logic in order to identify and avoid mistakes in reasoning is an important critical thinking skill. In similar vein, one of the final recommendations of the 1975 Conference on Basic Mathematical Skills

and Learning was that students should be taught to inspect all results in mathematics, checking for reasonableness in terms of the original problem.

Further, if the student does not know what to do in a given situation, all the arithmetic skill in the word is useless. "To know how, but not when, to add is precisely equivalent to knowing how to spell a word, but not knowing what it means" (Braunfeld, 1976, p. 24).

The opportunity to use mathematics should be provided for students, both by giving them real-world situations to work with (Tyler, 1976) and by giving them a chance to think about applications of math to problems. Pollak (1970, p. 328) says ". . . the heart of applied mathematics is the injunction, 'Here is a situation; think about it'."

The Beginning Teacher Evaluation Study (1976) shows that teachers do make a significant contribution to children's learning and that patterns of practices, rather than single practices or skills account for effectiveness. Material alone is not sufficient, they found, and no one way of organizing, or mixture of ways, is consistently effective in second and fifth grade math and reading. However, consistent with the essence of all the other findings in this paper, patterns of classroom organization which provide more direct instruction to pupils by teachers improve learning.

For fifth grade reading the BTES found that sustained interactions with students were effective: conducting discussions, giving explanations, questioning and answering questions. It was concluded that the teacher's task is to stimulate a higher level of thinking about the reading material for better comprehension.

Ability grouping is not effective for low achieving students, the

compensatory education studies reported (Brophy & Evertson, 1974). It does not lead to desirable effects either in achievement or in affective areas. This, too, is consistent with other findings on the necessity of individual attention. It may well be that grouping tends to inhibit individual diagnosis and treatment.

Instructional events, the research indicates, should provide for attention to individual student needs, convergent questions, drill, academic feedback and correction, an accepting climate with positive contacts between pupils and teacher. The teacher is encouraged to use logic, to encourage students to use logic in examining his or her own responses and to provide real-world situations for the student to work with.

The patterns of practices of the teacher are found to have a significant effect on children's learning, and implications of the research provide a substantial number of hints or suggestions about the appropriate thrust of those patterns of practices. Some of the implications, and suggestions about practice are summarized in the following sections on Strategies and Methods, and in the Recommendations of the Experts.

## IMPLI ATIONS FOR PRACTICE

### Strategies

Some of the instructional strategies that are expressed or inferred in the research are summarized in this section.

1. Introduction of words at a more rapid pace in beginning reading tends to produce pupils with superior word recognition abilities at the end of the first grade (Bond & Dykstra, 1967, pp. 210-212). The significance of this generalization is that if students are having difficulty with word recognition, the pace of introduction of new words should be examined.

2. A writing component is likely to be an effective addition to first grade reading (ITA, phonic linguistic and language experience orientations encourage writing letters with good results) (Bond & Dykstra, 1967, pp. 210-212). Indeed, addition of language experiences to any kind of reading program makes a difference (Bond & Dykstra, 1967, pp. 210-212).

3. Students learn most efficiently when a set for diversity is established. That is, when children are taught not to expect letters and sounds will always correspond in the same way (Levin & Watson, 1963; Levin, Baum, & Bostwick, 1963). Teaching children to expect one-to-one constant mapping of letters to sounds is the least effective way to promote transfer in decoding (Gibson, 1975). This seems to suggest a strategy of introducing irregular words early in instruction.

4. Same and different should be taught in kindergarten (Caldwell & Hull, 1969).

5. Tracing or copying single letters is less effective for later recognition than giving practice, without reproduction, in discriminating word pairs that differ only slightly (Williams, 1969).

6. Redundancy is distracting. Flashcards which have both picture and word produce significantly more errors than words alone (Samuels, in press).

7. Word study skills must be emphasized and taught systematically regardless of reading method (Bond & Dykstra, 1967).

8. Much of the literature seems to support Bateman's statement on decoding emphasis. Intensive, systematic decoding emphasis results in better reading achievement than do other kinds of beginning reading strategies (in press).

9. A study of oral reading by children in grades 4-6 concludes that oral reading for diagnosis is both valuable and necessary (Christensen, 1968).

10. Practice and use of easy materials are important in developing fluency. Repeated reading of the same passage and/or reading while listening are helpful (Chomsky, in press).

11. There appears to be consensus among the mathematics researchers that concrete materials are necessary for understanding of mathematics, at least at the elementary school level. Using Bruner's (1960) three levels: enactive, iconic, symbolic, Shulman (1970) says the child should manipulate materials directly, even through mental image before manipulating symbols.

12. The fear of math in some children can be overcome by encouraging the use of invented strategies, i.e., finger-counting, etc., with which the child may be comfortable (Ginsberg, 1975). Similarly, guessing is discouraged by some teachers, but Henkin (1975, p. 78) points out that "guessing is the heart of mathematical activity, both pure and applied. We must find ways of making students good at it."

Methods

The research indicates that differences in method alone do not alter the

reading growth in children. Of course each method of instruction has its advocate, but the research seems to support the use of more than one method. Any combination of methods was found to be better than any one method alone (Bond & Dykstra, 1967). Trabasso (in press) pointed out that a majority of the LRDC Reading Conference participants favored a code emphasis for beginning reading.

The research does provide information of use to practitioners on teaching method in spite of lack of consensus on a "best" method. This is summarized in this section.

1. In the report on twenty-seven projects supported by USOE, Bond and Dykstra reported that ITA (initial teaching alphabet method) produced somewhat better readers across all levels of intelligence than did basal readers.

2. Word recognition skills also are better in children who are taught with non-basal reading materials, especially ITA, phonic-linguistic and basal plus phonics (Bond & Dykstra, 1967).

3. Paragraph meaning and spelling skills are superior in students taught by phonic-linguistic methods compared to those taught by basal methods. However, rate and accuracy are <u>not</u> superior in students taught by phonic-linguistics compared with those taught by basal series (Bond & Dykstra, 1967).

4. Basal and phonics combinations were found to be somewhat better than basal alone across all levels of intelligence. A phonics-linguistic combination was better than basal across all levels of intelligence, also (Bond & Dykstra, 1967, pp. 164-168). In short, combinations of approaches often were found to be superior to single approaches in the teaching of reading.

but method alone was not sufficient to alter reading growth.

These findings seem to support the addition of instructional materials using phonic-linguistic or language experience methods to any totally basal program. Many of the generalizations listed under other components of this compilation also support this conclusion.

5. Chall (1967) claims that methods which have a code emphasis, teaching the sound value of letters, produce better overall reading achievement by fourth grade than methods with a meaning emphasis. The differences are greater for children of average or below average aptitude and lower socio-economic background.

Chall says the child will read faster, early in learning to read, when meaning is emphasized, but that advantage is lost by third grade, and by that grade the code-emphasis learner has caught up and s/he has a better vocabulary and comprehension by grade two on silent reading tests.

6. Prereading should include listening games that require identifying initial, medial and final phonemes in spoken words (Liberman, in press). Liberman has found a high and significant correlation between phoneme segmentation and early reading ability.

7. For math, Scandura (1964) reports that students taught math by a discovery method rather than an expository method are better able to handle problem tasks.

8. Fehr, McMeen and Sobel (1956) reported that use of a calculator resulted in increased achievement scores in math.

9. Harshman et al., (1962) found that teacher made math materials were as effective as either expensive or inexpensive purchased materials.

10. The use of manipulative materials at every grade level was supported by most mathematics researchers and manipulatives are supported by more studies than use of pictorial or abstract procedures. Also, it is not true that low achievers have greater need to use manipulatives than high achievers (Carney, 1973; Gregory & Osborne, 1975; Smith, 1974).

11. All three levels should be taught in mathematics: computation, comprehension and problem solving, according to Begle (1976), and he reports that frequent testing is an advantage.

12. Use of a variety of materials in both second grade and fifth grade math was found by the Beginning Teacher Evaluation Study (1976) to be ineffective. The implication of this was reported to be, probably, the necessity for an orderly sequence of problems from simple to complex to facilitate grasping of concepts and operations. It was suggested that the use of a variety of materials may disrupt the order or introduce extraneous ideas. Again, we find this consistent with some of the underlying assumptions of this paper which were implied when the Cooley-Lohnes constructs were selected for organization of the research: structure is important, on-task time is important. On the other hand, it has been found that homework seems to contribute very little to achievement in mathematics (Begle, 1975).

## RECOMMENDATIONS OF THE EXPERTS

The experts in reading and math have been willing to supply practitioners with a host of recommendations. Some of these which might be useful to the PSIP are listed in this section.

1. Chomsky (in press) recommends that children be allowed to write before they read if they begin spontaneously to do so. Developmentally, she says, writing is less abstract and easier to learn. She has found that some children invent their own spelling which is highly systematic and fairly uniform from child to child. They do not have any trouble, she finds, converting to traditional spelling later on.

Some children, she says, enjoy using plastic or wooden letters, rather than attempting to use their own handwriting. They still use the thought processes that go into writing and eventually reading, if they write their messages with these manipulable letters.

2. Clay (in press) recommends that since directional conventions are arbitrary, they should be taught and that children should be encouraged to confirm or correct their own responses by use of meaning, sentence structure, and letter detail.

3. McCullough (1968) recommends that the child who knows from home and school that reading is a way of getting meaning, thinking about resultant ideas and using them, who has good auditory discrimination and a good speaking vocabulary may do well with a phonic emphasis in beginning reading.

Subject area teachers in upper levels should be encouraged to help students build vocabulary and become word collectors. Libraries should contain multi-level materials.

Teachers should record introductions to books on tape to help children "get into" them by listening while reading the introduction (McCullough, 1968).

4. School administrators must give interest and attention to the reading program. This appears to make the difference when similar communities and materials produce different results (Bond & Dykstra, 1967; Carroll & Chall, 1975).

School administrators may have to provide additional personnel and resources for children 5 to 8 because these ages require an intensive period of assessment and preventive measures, diagnosis and correction of disabilities (Carroll & Chall, 1975, p. 30).

5. Hard to teach childrem may not do well with noise and distractions of open space environment and may do better with homogeneous grouping (Rosner, in press).

6. Reading programs should be examined in terms of:

a. The extent to which the basic concepts of phoneme-grapheme relationships are made explicit (i.e., the extent to which phonetic principles are introduced overtly and precisely as against being implied).

b. The extent to which appropriate chunks - larger units of analysis - strings of letters - are taught explicitly.

c. The extent to which drill and practice materials are made available and interesting (Rosner, in press).

7. There should be coordination of reading with spelling, composition, literature, listening and speaking, and follow through of the reading program throughout the school years with extension into specialized content areas (Carroll & Chall, 1975).

8. Phonics should appear in children's books as well as in teacher's manuals. The sound program should parallel sight from the beginning. Vowels and consonants should be introduced in an order that produces the largest number of words. As much attention should be paid to phonics use as to teaching phonics. And, finally, instruction should demand continuous response of every child (McCullough, 1968).

9. Parents should have children watch Sesame Street for prereading and The Electric Company for ages 7 to 10. They have been validated extensively and show clear gains in goal achievement (Ball & Bogatz, 1970, 1973; Bogatz & Ball, 1971; Herriott & Liebert, 1972).

10. Tyler (1976) recommends that for children who have not had the opportunity to be read to, perhaps the objective of beginning reading should be to help him/her to enjoy hearing material that is read to him/her.

11. Parents (and teachers) probably are aware, but if not, should be aware that decoding is a crucial skill. It is the most common source of problems for children who have difficulty in beginning reading and unless it is mastered, acquisition of higher level skills is disrupted (Chall, 1967).

12. Never discourage a child's spontaneous attempts to read phonemes. "The child must learn to hear the difference between bet and get, bat and bed, ham and hem, little and riddle" (Gibson, 1975).

13. Children should be exposed to writing very young (Gibson, 1975).

14. Words should be introduced at as fast as pace as possible (Bond & Dykstra, 1967).

15. Reading readiness is both maturation and environmental factors,

and reading to preschool children, talking with them and answering their questions are important. On the other hand, in some communities, parents need help in distinguishing between intellectually stimulating and smothering (Durkin, 1968).

16. Parents should be straightened out on traditional misconceptions with no research base, such as that preschool reading leads to boredom or confusion when school instruction begins, or that preschool reading will harm a child's vision. Helpful for teaching of preschoolers are TV, labels on pictures, alphabet books and picture dictionaries and help from other brothers and sisters. Such training "adds concrete meaning to the most abstract letter-sound relationships stressed in school" (Durkin, 1968).

17. If an eighth grade student has trouble computing, give him or her a calculator, suggests the Conference Board of Mathematical Sciences (1975). The report deplored the amount of time spent developing a facility in fundamental arithmetic operations.

18. A suggestion for teacher's assessment of student reading level is provided by Calfee and Drum:

> To determine student's level, grades 1-8, choose a few lists of words arranged by difficulty level and ask the student which lists he can read. If his assessment agrees with his later performance, he knows realistically what he can do. If he is two or three levels below, he at least has a good self concept, and if he can read all the lists, give him a harder one. The same procedure can be used for meanings and paragraph comprehension (Calfee & Drum, 1967, p. 28).

19. In addition to all these recommendations, the teacher should conduct a well-organized, systematic reading program, encourage class participation by <u>all</u> pupils and be aware of and adjust to individual needs of pupils within her classes (Bond & Dykstra, 1967).

## STUDENT AND TEACHER CHARACTERISTICS

### Student Characteristics

Perceptual Skills:

Albert J. Harris, has pointed out some of the perceptual difficulties children may have with beginning reading. Simply to read them suggests instructional possibilities and the necessity of reminding teachers that they may be the cause of reading problems. The list includes comparing parts within wholes (visual and auditory), distinguishing figure from background, filling in missing parts, grasping sequential arrangement, directional difficulty (reversals in reading and writing), integrating parts into a recognizable whole (blending) and establishing associations between sensory modalities (sound of letter and appearance) (1961).

The research of George W. McConkie shows that limiting the perceptual span of skilled readers which essentially turns them into word-by-word readers, slows them down but does not reduce their comprehension. This gives no support to the notion that narrow perceptual span is a cause of poor comprehension by poor readers (1976).

Rosner points out that visual analysis skills tend to relate to arithmetic and to reading and listening comprehension. Auditory skills tend to relate to primary grade aspects of reading (decoding) (Rosner, 1973).

Rosner also reminds us that one cannot expect compensatory education children to induce phonetic values from appropriate examples (Rosner, in press).

Prerequisites:

Awareness that spoken words can be analyzed into their component sounds

is a critical prerequisite to reading (Mattingly, 1972).

Knowledge of letter names prior to initial instruction accounts for 25%-30% of the variation in reading ability at the end of the first year (Bond & Dykstra, 1967, p. 206). Kindergarten children tested in 1970 on ability to name each of the 26 upper-case English letters took the cooperative Primary Reading Test (ETS, 1970), two years later at the end of first grade (144 of the original 276). The correlation between alphabet knowledge and reading achievement was .50 (Calfee & Drum, in press).

This suggests kindergarten instruction in the alphabet and possible communications to parents, to inform them of the relationship between the knowledge of letter names and reading achievement. Of course the relationship may not be causal, but because of the dearth of information (Carroll & Chall, 1975), it seems wise to act as though it is, and attempt to find out if it is. That kind of in-school research may be the most productive, and I believe we have to assume it will be, and use all the clues the literature suggests to us.

Age and Sex:

A student's age in beginning reading is only slightly related to achievement, but teachers should not expect boys to achieve at the same levels as girls, who have greater readiness at first grade entrance and are ahead at the end of the first grade (Bond & Dykstra, 1967, pp. 147 and 210-212).

Samuels and Turnure (1974) have pointed out that girls are significantly more attentive in class than boys and also read better. The attentiveness, rather than any genetic factor, however, may be the cause.

Bateman (in press) suggests a strategy for teaching learning disabled

children selective attention in reading. Exaggerate differences between stimuli to be discriminated, making critical patterns more obvious. DISTAR, for example, uses different type styles for letters b and d for this purpose.

Bilingual and Dialect Readers:

Children of foreign language background, children with hearing loss and children who do not hear the differences among some English consonants and vowels may have trouble with phonics (McCullough, 1968). In addition, poor auditory discrimination is frequent among disadvantaged children and they find phonics difficult, too (Deutsch, 1964).

The role of black dialect in the difficulty black children have in reading can best be understood by observing teacher student interaction. It may be the teacher does not recognize black dialect, but also tries to get the child not only to recognize a word, but pronounce it in standard English. Also, a teacher may use indirect means of telling a child s/he is wrong which, coming from a different culture, he does not understand, i.e., "Pardon me?" "Get your finger out of your mouth," "Start again" (Simons, in press).

Natalico (in press) suggests teaching reading English to the bilingual child but allowing use of native language with other children and teacher in the first year, teacher interaction with student only in second language but translating questions and comments, and responding to them only in the target language. Research results in Canada indicate the direct approach to learning a second language was successful. In Spanish use of Spanglish with three origins and different dialects must be recognized by the teacher as a complication.

Danks and Fears (in press) points out that a teacher must realize when a child who translates what s/he is reading into his/her own dialect, the child is reading correctly. Undue pressure should not be imposed by constantly correcting oral productions. This also confuses the child.

Hemisphere Dominance:

The teacher should be made aware of some of the problems of children with incomplete lateralization or mixed or reversed hemisphere dominance. A conflict between hemisphere dominance and the direction of letters can lead to the reversal of letters or even words. Children with right brain damage tend to begin to read or write in the middle of the page. In reading, the gaze will fail to return to the beginning of the next line and may omit several lines. In writing, the material begins in the center of the page and slopes towards the right. One of the major problems of dyslexia is the inability to read letters and words in the correct order (Mackworth, in press).

Expectations:

The expectations for student achievement probably are too low. Pupils are better equipped than they used to be when they enter first grade. Programs which introduce words at a more rapid pace tend to produce pupils with superior word recognition abilities at the end of first grade (Bond & Dykstra, 1967, pp. 210-212).

Other Student Differences:

A language experience approach, which begins with the child's own language, which he dictates, sees written by the teacher and later writes and reads is high in motivation and meaningfulness. It is good for the child who is fluent in English, who enunciates well and has good hand-eye

coordination. The child who has a behavior problem, which includes a need to be the center of attention, may do well with this method (McCullough, in press).

For those who have failed in reading and, therefore, find letters and words aversive, systematic extrinsic reinforcement may be necessary (Bateman, in press).

The five tasks (or subskills) on which the learner's selected attention must be focused in decoding are:

1. letter differentiation.
2. association of letter and sound.
3. blending sounds.
4. identification of a sound within a word.
5. sound matching within words (Bateman, in press).

When lack of interest in learning is the cause of lack of success, because friends and family do not think learning is important, the teacher should go out of his way to find out more about the pupils and use examples of interest to them, and should show his own respect for the subject matter (Willoughby, 1970).

Danks and Fears (in press) suggest that if a child does not seem to understand what s/he is reading, s/he might not have understood aurally either. The child may have a general language or conceptual deficit rather than a deficiency in reading-specific comprehension skills.

Wallach and Wallach (1976) agree with Chall (1967) that if a child has trouble decoding and loses meaning, more decoding is needed, not less. Disadvantaged children not only need more decoding, but they are lacking in skills of recognition and manipulation of basic speech sounds. This is not lack of auditory discrimination ability, they found, but lack of skill

development. These children need a systematic sequence of instruction in phoneme recognition skills. Tutoring sessions with low readiness children in inner-city schools for 1/2 hour every school day for 2-1/2 months resulted in 99% mastering the sound of every letter in the alphabet.

In mathematics, Herriot (1967) found that slow learning students achieve as well in SMSG math as average students when allowed substantially more time (two years for one).

## Teacher Characteristics

### Experience and Training:

Of 27 USOE sponsored first grade reading projects, the five highest and five lowest achieving projects were compared. Of the top five, 76% of the teachers were rated by their supervisors as overall competent. Of the bottom five projects, only 24% of the teachers were rated as having overall competence. At the other extreme, 38% of the teachers in the 5 lowest projects were given low competence ratings while only 7% were so rated in the high ranking projects (Bond & Dykstra, 1967, p. 196).

The amount of support the teacher receives for carrying out an innovation makes a difference. Inservice training is very important to success of instruction. The number of days of inservice training has been found to be positively related to program effectiveness (Sweeney & Blaschke, 1975). Supporting this is a similar finding by Wargo and others (1972) that teacher training in program methods was one of the components that characterized successful Title 1 programs.

An indication of the value of both experience and training is the fact that amount of experience, was somewhat related to pupil achievement in the first grade reading study. A greater amount of teacher training and more

advanced certification were found among high ranked projects. Indeed, correlation of level of certification to achievement (teachers having more than standard certification) was significant at the .01 level (Bond & Dykstra, 1967, p. 196).

Evidence is overwhelming that most teachers are not adequately prepared to teach reading and few elementary teachers have had any separate course in teaching of reading (Austin, 1968; Carroll & Chall, 1971; Harsh, 1971). Particularly, teachers-in-training and teacher educators report insufficient preparation of teachers in diagnosis of pupils' reading problems and use of individualized or special techniques for remediation of reading difficulty (Rystrom, 1970; Shuy, 1976).

That teachers may not be any better prepared in math may be inferred from the report by Davis (1975) whose reliable data indicates that about 25 percent of undergraduates entering elementary education are unable to answer correctly many of the standardized tests of elementary school arithmetic. They cannot correctly answer problems in long division, decimals and percent. At graduation the same percentage of students still show the same weakness in arithmetic.

Traits and Style:

Rosner has suggested teacher traits and behaviors that should be cultivated for accommodating to each student's unique characteristics in teaching reading (Rosner, in press):

1. The extent to which the teacher is aware of the relevant dimensions of teaching reading - the basic concepts - the principles that underlie the various reading programs. (PSIP selection, installation procedures should assist this understanding).

2. The extent to which the teacher is willing to be pedantic (not discovery), precise and repetitive.

3. The extent to which the teacher can perform in a structured, relatively non-dynamic environment. Hard to teach children seem to require a structured setting.

4. The extent to which the teacher can cope with a slowly-rising, small increment learning curve for hard to teach children.

Further recommendations from Carroll and Chall (1975) are for better teacher training overall and the following teacher attitudes and behavior:

1. The teacher must be flexible in use of teaching methods and materials.
2. The teacher must be convinced all children can learn to read.
3. The teacher must give attention to individual children and recognize children who need special help.
4. The teacher should avoid over-anxiety which can be communicated to the child.

That the teacher's teaching style is important was clearly shown by the Beginning Teacher Evaluation Study (1975) which indicated that in second and fifth grade classrooms in reading and math, clear differences could be identified between more and less effective behavior. More effective teaching behavior was associated with a consistency of the message conveyed by the teacher: attending; monitoring learning, pacing and structuring; accepting; acting optimistic; projecting a warm, positive, congenial, cooperative attitude; keeping students working, playing with purpose, and responsible for their own behavior and work.

## CONCLUSION

Important to the Pennsylvania School Improvement Program are several related research findings. Project LONGSTEP found that the impact of educational practices is inversely related to grade level (1976). It found, also, that increasing the amount of class time per day, especially in the first and second grade, may be a worthwhile strategy for improving student performance in language arts. Willoughby (1970) reported that the higher the grade level the less seems to be the effect associated with the textbook in math. These results seem to point to the greater impact on achievement that can be attained by concentrating change efforts in the early grades.

Geraldine Joncich Clifford (1973) has urged researchers and teacher-educators to recognize that research provides a kind of legitimation, explaining what <u>is</u> education. "The weakest section of research reports," she says, "is the practical implications section. Implications must be at least as elaborated as the research design. Better still would be the requirement that the implications be tested."

There is some value in the explaining and this paper has synthesized the research in basic skills that seems to have some significance in relation to the work of the Pennsylvania School Improvement Program. It will not be unfamiliar to teacher-educators, but it will confirm many of their perceptions and may offer a few surprises. No attempt will be made to summarize the myriad research results reported here. Each section provides its own focus. Research which has powerful implications for practice has been selected and the implications of the research have been carefully highlighted. Perhaps the PSIP will have an opportunity to test some of these

implications in the process of conducting their knowledge utilization/dissemination study.

Guthrie (1976), discussing the powerful effect of on-task time on reading achievement, suggests that instructional time is probably an approximation of the intensity of teaching or instruction. This concept is consistent with the research compiled on instructional events and structure as well. The tightness of structure and sequencing, the organization of the classroom and the cognitive nature of the interaction seem to be the significant factors in student achievement in basic skills. The research seems to endorse the significance of the constructs used to organize it.

At the end of the Della-Piana, Endo report on Reading Research (1973) which reports on the work of many of the researchers who were participants in the LRDC Reading Conference, and who were reported in this paper as well, the recommendation was made that practitioners should develop expertise to identify and evaluate products. They should select the best for their "outcome-population-time-cost complex." The report also recommended that they should develop the expertise in their staff to "make maximum use of the technologies for installing, monitoring and adapting those best products."

That is precisely what the PSIP is planning to help the practitioners to do. This synthesis of the research is one step in the process.

* * * * * * *

Addendum:

Although different participants at the Euclid Conference on Mathematics suggested somewhat different necessary content, there was enough consensus to

report on goals (with a recommendation that they be open to broader input). They are in Appendix IV.

Also appended are three tables which might be used in program analysis or selection. One is taxonomy of reading comprehension (Appendix 1); one lists bases for evaluation of readers and related materials (Appendix II); and the third analyzes 13 reading programs in terms of selected variables.

## Bibliography


Amidon, E. J., & Giammatteo, M. M. The verbal behavior of superior elementary teachers. In E. J. Amidon & J. B. Hough (Eds.), Interaction Analysis: Theory, Research and Application. Reading, Mass.: Addison-Wesley Publishing Co., 1967, pp. 186-188.

Armento, B. Correlates of teacher effectiveness in social studies. Doctoral Dissertation, Indiana University, 1975.

Armstrong, J. M. Basic mathematical skills. NIE Conference on Basic Mathematical Skills and Learning (Vol. 1). Euclid, Ohio, 1975, 8-12.

Austin, M. Professional training of reading personnel. In H. M. Robinson (Ed.), Innovation and Change in Reading Instruction, National Society for the Study of Education 67th Yearbook, Part II, Chicago: University of Chicago Press, 1968, 357-396.

Ausubel, D. Some psychological aspects of the structure of knowledge. In S. Elam (Ed.), Education and the Structure of Knowledge, Fifth Annual Phi Delta Kappa Symposium on Educational Research. Chicago: Rand McNally & Co., 1964, pp. 220-252.

Ball, S., & Bogatz, G. A. The First Year of Sesame Street: An Evaluation. Princeton: Educational Testing Service, 1970.

Ball, S., & Bogatz, G. A. Reading with Television: An Evaluation of the Electric Company. Princeton: Educational Testing Service, 1972.

Bateman, B. Teaching reading to learning disabled children: A fourth approach. In L. Resnick & P. Weaver (Eds.), Theory and Practice of Early Reading. Hillsdale, N.J.: Lawrence Erlbaum Associates, in press.

Beginning Teacher Evaluation Study: Phase II Summary. Washington, D.C.: National Institute for Education, 1976.

Begle, E. G. Mathematics Education, 69th Yearbook, National Society for the Study of Education. Chicago: University of Chicago Press, 1970.

Begle, E. G. Basic skills in mathematics. NIE Conference on Basic Mathematical Skills and Learning (Vol. 1). Euclid, Ohio, 1975, 13-18.

Bloom, B. S. Time and learning. American Psychologist, 1974, 29, 632-688.

Bogatz, G. A., & Ball, S. The Second Year of Sesame Street: A Continuing Evaluation. Princeton: Educational Testing Service, 1970.

Bond, G. L., & Dykstra, R. Final Report. (USOE, HEW Project #001-0E-5-10-264). Minneapolis: University of Minnesota, Coordinating Center for First Grade Reading Instruction Programs, 1967.

Braunfeld, P. Basic skills and learning in mathematics. NIE Conference on Basic Mathematical Skills and Learning (Vol. 1). Euclid, Ohio, 1975, 23-32.

Briggs, L. J. Handbook of Procedures for the Design of Instruction. Pittsburgh: American Institutes for Research, 1970.

Brophy, J. E., & Evertson, C. M. Process - product moment correlations in the Texas teacher effectiveness study, Final Report. Austin, Texas: University of Texas, 1974.

Bruner, J. S. The Process of Education. Cambridge: Harvard University Press, 1960.

Brownwell, W. Meaning and skill. The Arithmetic Teacher, 1956, 3, 129-136.

Caldwell, W., & Hall, V. The influence of concept training on letter discrimination. Child Development, 1969, 40, 63.71.

Calfee, R. C., & Drum, P. A. How the researcher can help the teacher with classroom assessment. In L. Resnick & P. Weaver (Eds.), Theory and Practice of Early Reading. Hillsdale, N.J.: Lawrence Erlbaum Associates, in press.

Carney, J. F. The relative effectiveness of two methods of teaching addition and subtraction of rational numbers. (Doctoral Dissertation, New York University, 1973). Dissertation Abstracts International, 1975, 1, 11.

Carroll, J. B. A model of school learning. Teacher's College Record, 1963, 64, 723-733.

Carroll, J. B., & Chall, J. S. Towards a Literate Society, The Report of the Committee on Reading of the National Academy of Education. New York: McGraw Hill Book Co., 1975.

Chall, J. Learning to Read: The Great Debate. New York: McGraw Book Co., 1967.

Chang, S. S., & Raths, J. P. The schools: Contributions to the cumulating deficit. Journal of Educational Research, 1971, 64.

Chomsky, C. Approaching reading through invented spelling. In L. Resnick & P. Weaver (Eds.), Theory and Practice of Early Reading. Hillsdale, N.J.: Lawrence Erlbaum Associates, in press.

Christensen, J. Oral reading errors of intermediate grade children at their independent instructional and frustration reading levels. International Reading Association Conference Proceedings, pt. 1, 13, April 1968, 647-677.

Clay, M. M. Theoretical research and instructional change: A case study. In L. Resnick & P. Weaver (Eds.), Theory and Practice of Early Reading. Hillsdale, N.J.: Lawrence Erlbaum Associates, in press.

Clifford, G. J. A history of the impact of research on teaching. In R. M. W. Travers (Ed.), Second Handbook of Research and Teaching. Chicago: Rand McNally & Co., 1973, pp. 1-46.

Clymer, T. What is reading?: Some current concepts. In H. M. Robinson (Ed.), Innovation and Change in Reading Instruction, 67 Yearbook of the National Society for the Study of Education, Part II. Chicago: University of Chicago Press, 1968, 7-29.

Common Characteristics of Successful Compensatory Education Programs. Washington, D.C.: Health, Education and Welfare, USOE, 1974.

Conference Board of Mathematical Sciences. Overview and Analysis of School Mathematics, Grades K-12. Washington, D.C., 1975.

Cooley, W. W., & Lohnes, P. R. Evaluation Research in Education. New York: Irvington Publishers, 1976.

Cooley, W. W., & Leinhardt, G. The application of a model for investigating classroom processes. Pittsburgh: University of Pittsburgh, Learning Research and Development Center, 1975.

Cooley W. W., & Leinhardt, G. Evaluation of individualized education in the elementary school. Pittsburgh: University of Pittsburgh, Learning Research and Development Center, 1975.

Danks, J. J., & Fears, R. Oral reading: Does it reflect decoding or comprehension? In L. Resnick & P. Weaver (Eds.), Theory and Practice of Early Reading. Hillsdale, N.J.: Lawrence Erlbaum Associates, in press.

Davis, R. B. Basic skills and learning in mathematics. NIE Conference on Basic Mathematics Skills and Learning (Vol 1). Euclid, Ohio, 1975, 42-50.

Della-Pina, G. M., & Endo, G. T. Reading research. In R. M. W. Travers (Ed.), Second Handbook on Teaching. Chicago: Rand McNally & Co., 1973, 883-925.

Deutsch, C. P. Auditory discrimination and learning: Social factors. Merrill-Palmer Quarterly of Behavior Development, July 1964, 10, 277-296.

Durkin, D. When should children begin to read? In H. M. Robinson (Ed.), Innovation and Change in Reading Instruction, 67 Yearbook, National Society for the Study of Education. Chicago: University of Chicago Press, 1968, 30-71.

Elam, S. Education and the Structure of Knowledge. Chicago: Rand McNally & Co., 1964.

Evaluating Compensatory Education. An Interim Report on the NIE Compensatory Education Study. Washington, D.C.: National Institute of Education, 1976.

Fehr, H. F., McNeen, G., & Soble, M. Using hand-operated computing machines in learning arithmetic. The Arithmetic Teacher, 1956, 145-150.

Fletcher, J. D. Computer assisted instruction in beginning reading. In L. Resnick & P. Weaver (Eds.), Theory and Practice of Early Reading. Hillsdale, N.J.: Lawrence Erlbaum Associates, in press.

Gagne, N., & Berliner, D. C. Educational Psychology. Chicago: Rand McNally & Co., 1975.

Gagne, R. M. The Conditions of Learning. New York: Holt Rinehart and Winston, Inc., 1965.

Gibson, E. J. Theory based research on reading and its implication for instruction. In J. B. Carroll & J. S. Chall (Eds.), Toward a Literate Society. Report from the National Academy of Education. New York: McGraw Hill Book Co., 1975, pp. 288-321.

Ginsberg, H. Basic mathematical skills and learning. NIE Conference on Basic Mathematical Skills and Learning (Vol. 1). Euclid, Ohio, 1975.

Goldberg, M., Passow, A. H., & Justman, J. The Effects of Ability Grouping. New York: Teacher's College Press, 1966.

Goodman, K. S., & Goodman, Y. M. Learning to read is natural. In L. Resnick & P. Weaver (Eds.), Theory and Practice of Early Reading. Hillsdale, N.J.: Lawrence Erlbaum Associates, in press.

Gordon, E. W. Theories and practice of beginning reading: A view from the back of the bus. In L. Resnick & P. Weaver (Eds.), Theory and Practice of Early Reading. Hillsdale, N.J.: Lawrence Erlbaum Associates, in press.

Gow, D. T. An analysis of individualized science. Pittsburgh: University of Pittsburgh, Learning Research and Development Center, in press.

Gow, D. T. Design and Development of Curricular Materials. Pittsburgh: Center for International Studies Publications, 1971.

Gow, D. T. PIC: A process model for the individualization of curricula. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, 1973.

Grauws, D., & Good, T. L. Factors associated with third and fourth grade children's performance in solving multiplication and division sentences. Journal for Research in Mathematics Education, 1976, 3, 155-171.

Gregory, J. W., & Osborne, A. R. Logical reasoning ability and teacher verbal behavior within the mathematics classroom. Journal for Research in Mathematics Education, 1975, 6, 26-36.

Guthrie, J. T. Impacts of instructional time on reading. In L. Resnick & P. Weaver (Eds.), Theory and Practice of Early Reading. Hillsdale, N.J.: Lawrence Erlbaum Associates, in press.

Harnischfeger, A., & Wiley, D. W. Teaching learning processes in elementary school: A synoptic view. Beginning Teacher Evaluation Study, Technical Report #75-3-1. San Francisco: Far West Laboratory for Educational Research and Development, 1975, (mimeo).

Harris, A. J. Perceptual difficulties in reading disability. In J. A. Figural (Ed.), Changing Concepts of Reading Instruction. International Reading Conference Proceedings II, 1961, 281-290.

Harris, A. J. Diagnosis and remedial instruction in reading. In H. M. Robinson (Ed.), Innovation and Change in Reading Instruction, 67 Yearbook of the National Society for the Study of Education, Part II, Chicago: University of Chicago Press, 1968, 159-194.

Harris, A. J., & Sipay, E. R. How to Increase Reading Ability. New York: David McKay Co., Inc., 1975.

Harris, A. J. et al. A continuation of the CRAFT project: Comparing reading approaches with disadvantaged urban Negro children in primary grades. New York: Division of Teacher Education of the City University of New York, (USOE), 1968.

Harsh, J. Nature and extent of current practices in educating those who teach reading. In R. Corder (Ed.), The Information Base for Reading. Berkeley: Educational Testing Service, 1971, pp. 138-219.

Harshmen, H. W., Wells, D. W., & Payne, J. N. Manipulative materials and arithmetic achievement in grade 1. The Arithmetic Teacher, 1962, 9, 188.192.

Henkin, L. Skills and skills. NIE Conference on Basic Mathematical Skills and Learning (Vol. 1). Euclid Ohio, 1975, 75-80.

Herriot, S. T. The slow learner project: The secondary slow learner in mathematics. Stanford University, SMSG Report #5, 1967.

Herriott, R. E., & Liebert, R. J. The Electric Company: In-school Tallahasse utilization study. Florida: Institute for Social Research, Florida State University in conjunction with the Research Triangle Institute, 1972.

Impact of Educational Innovation on Student Performance, (Project LONGSTEP Final Report, Vol. 1). Stanford: American Institutes for Research, 1976.

Jorgenson, G. W. An analysis of teacher judgments of reading level. American Educational Research Journal, 1975, 12, 67-75.

Lester, F. Developmental aspects of children's ability to understand proof. Journal for Research in Mathematics Education, 1975, 6, 23.

Levin, H., Baum, E., & Bostwick, S. The learning of variable grapheme-phoneme correspondence: Comparison of English and Spanish speakers. In A Basic Research Program on Reading, Final Report Project #639. Washington, D.C.: Cornell University and USOE, 1963.

Levin, H., & Gibson, E. J. The Psychology of Reading. Cambridge: The MIT Press, 1975.

Levin, H., & Watson, J. The learning of variable grapheme-to-phoneme correspondence. In A Basic Research Program on Reading, Cornell University Cooperative Research Project #639, 1963.

Lewin, H., Lypitt, R., & White, R. Patterns of aggressive behavior in experimentally created social climates. In E. J. Amidon & J. B. Hough (Eds.), Interaction Analysis: Theory, Research and Application. Reading, Mass.: Addison-Wesley Publishing co., 1967, pp. 24-46.

Liberman, A. M., Cooper, F. S., Shankweiler, D. P., & Studdert-Kennedy, M. Perception of the speech code. Psychological Review, 1967, 74, 431-461.

Liberman, I. Y., & Shankweiler, D. Speech, the alphabet, and learning to read. In L. Resnick & P. Weaver (Eds.), Theory and Practice in Early Reading. Hillsdale, N.J.: Lawrence Erlbaum Associates, in press.

Mackworth, J. F. Cerebral laterality and reading. In L. Resnick & P. Weaver (Eds.), Theory and Practice of Early Reading. Hillsdale, N.J.: Lawrence Erlbaum Associates, in press.

McCullough, C. M. Balanced reading development. In H. M. Robinson (Ed.), Innovation and Change in Reading Instruction, 67 Yearbook of the National Society for the Study of Education, Part II. Chicago: University of Chicago Press, 1968, 320-256.

McConkie, G. W. What the study of eye movement reveals about reading. In L. Resnick & P. Weaver (Eds.), Theory and Practice of Early Reading. Hillsdale, N.J.: Lawrence Erlbaum Associates, in press.

Michigan Cost-Effectiveness Study. Washington, D.C.: Educational Turnkey Systems Inc., 1976.

Natalico, D. S. Reading and the bilingual child. In L. Resnick & P. Weaver (Eds.), Theory and Practice of Early Reading. Hillsdale, N.J.: Lawrence Erlbaum Associates, in press.

Nichols, E. D. Basic mathematical skills and learning. NIE Conference on Basic Mathematical Skills and Learning (Vol. 1). Contributed Position Papers, 1975, 128-135.

Novillis, C. An analysis of the fraction concept into a hierarchy of selected subconcepts and the testing of the hierarchical dependencies. Journal for Research in Mathematics Education, 1976, 3, 131-144.

Phillips, R. W. Mathematics survey of international education association. In Report on Education Research, Washington, D.C.: Capitol Publications, 1976.

Pollak, H. O. Applications of mathematics. In E. G. Begle (Ed.), Mathematics Education, 69th Yearbook of the National Society for the Study of Education. Chicago: University of Chicago Press, 1970, 311-334.

Resnick, L. Hierarchies in children's learning: A symposium. Instructional Science, 1973, 2, 333-362.

Reidesel, C. A., & Burns, P. C. Research on teaching of elementary school mathematics. In R. M. W. Travels (Ed.), Second Handbook of Research on Teaching. Chicago: Rand McNally & Co., 1973, pp. 1149-1176.

Romberg, T. A. Activities basic to learning mathematics: A perspective. NIE Conference on Basic Mathematical Skills and Learning (Vol. 1). Euclid, Ohio, 1975, 161-171.

Rosenshine, B. Objectively measured predictors of effectiveness of explaining. In The Ability to Explain, Technical Report #4. Stanford: Stanford Center for Research and Development in Teaching, 1968.

Rosenshine, B. Teaching Behaviors and Student Achievement. Slough, England: National Foundation for Educational Research in England and Wales, 1971.

Rosenshine, B. Classroom instruction. In N. L. Gage (Ed.), The Psychology of Teaching Methods, 75th Yearbook of the National Society for the Study of Education, Part I. Chicago: University of Chicago Press, 1976, 355-371.

Rosner, J. Language arts and arithmetic achievement and specifically related percpetual skills. American Educational Research Journal, 1973, 1.

Rosner, J. Discussion. In L. Resnick & P. Weaver (Eds.), Theory and Practice of Early Reading. Hillsdale, N.J.: Lawrence Erlbaum Associates, in press.

Rystrom, R. Dialect training and reading: A further look. Reading Research Quarterly, 1970, 5, 599-681.

Samuels, S. J. Attentional process in reading, the effect of pictures on the acquisition of reading responses. Journal of Educational Psychology, 1967, 58, 337-342.

Samuels, S. J. Discussion. In L. Resnick & P. Weaver (Eds.), Theory and Practice of Early Reading. Hillsdale, N.J.: Lawrence Erlbaum Associates, in press.

Samuels, S. J., & Turnure, J. E. Attention and reading achievement in first grade boys and girls. Journal of Educational Psychology, 1974, 66, 29-32.

Scandura, J. M. An analysis of exposition and discovery modes of problem solving instruction. Journal of Experimental Education, 1974, 33, 149-159.

Shulman, L. S. Psychology and mathematics education. In E. G. Begle (Ed.), Mathematics Education, 69th Yearbook of the National Society for the Study of Education. Chicago: University of Chicago Press, 1970, pp. 23-71.

Shutes, R. E. Verbal behaviors and instructional effectiveness. Doctoral dissertation, Stanford University, 1969.

Shuy, R. W. The mismatch of child language and school language: Implications for beginning reading instruction. In L. Resnick & P. Weaver (Eds.), Theory and Practice of Early Reading. Hillsdale, N.J.: Lawrence Erlbaum Associates, in press.

Simons, H. D. Black dialect, reading interference and classroom interaction. In L. Resnick & P. Weaver (Eds.), Theory and Practice of Early Reading. Hillsdale, N.J.: Lawrence Erlbaum Associates, in press.

Smith, F. Conflicting approaches to reading research and instruction. In L. Resnick & P. Weaver (Eds.), Theory and Practice of Early Reading. Hillsdale, N.J.: Lawrence Erlbaum Associates, in press.

Smith, J. W. The effect of achievement and attitude of three approaches for developing concepts. (Doctoral dissertation, University of Texas at Austin, 1973). Dissertation Abstracts International, 1974, 34A: 5497-5498

Soar, R. B. Follow-Through classroom process measurement and pupil growth. (1970-71), Final Report. Gainesville: University of Florida, College of Education, 1973.

Spache, G. D., & Spache, E. B. Reading in the Elementary School. Boston: Allyn & Bacon, Inc., 1976.

Stallings, J. Relation between classroom practices and child development. Menlo Park, Ca.: Stanford Research Institute, 1975.

Stallings, J., & Kaskowitz, D. H. Follow-Through classroom observation evaluation, 1972-73. Menlo Park, Ca.: Stanford Research Institute, 1974.

Suydam, M., & Higgins, J. L. Review and synthesis of studies of activity based approaches to mathematics teaching: Final Report. Ohio State University, Sept., 1976.

Sweeney, J., & Klaschke, C. The cost effectiveness of Michigan compensatory education programs. Washington, D. C.: Educational Turnkey Systems, 1975.

Tikunoff, W. J., Berliner, D. C., & Rist, R. C. Abstract from special study A: An ethnographic study of the forty classrooms of the beginning teacher evaluation study known sample. San Francisco: Far West Laboratory, 1975.

Trabasso, T. Reflections on two days of listening about reading. In L. Resnick & P. Weaver (Eds.), Theory and Practice of Early Reading. Hillsdale, N.J.: Lawrence Erlbaum Associates, in press.

Tyler, R. N. Two new emphases in curriculum development. Educational Leadership, May 1976, 33, 61-71.

Wallach, M., & Wallach, L. Helping disadvantaged children learn to read by teaching them phoneme identification skills. In L. Resnick & P. Weaver (Eds.), Theory and Practice of Early Reading. Hillsdale, N.J.: Lawrence Erlbaum Associates, in press.

Wargo, M. J., Talmadge, G. K., Michaels, D. D., Lippe, D., & Morris, S. J. ESEA Title I, A re-analysis and synthesis of evaluation data from fiscal year 1965 through 1970. AIR, 1972.

Weaver, J. F. The symmetric property of the equality relation and young children's ability to solve open addition and subtraction sentences. Journal for Research in Mathematics Education, 1973, 4, 45-56.

Wheatley, G. H. A comparison of two methods of column addition. Journal of Research in Mathematics Education, 1976, 7, 145-155.

Wiley, D. E. Another hour, another day: Quantity of schooling, a potent path for policy. Studies of Educative Processes, No. 3, Chicago: University of Chicago, July, 1973.

Wiley, D. W., & Harnischfeger, H. Explosion of a myth: Quantity of schooling and exposure to instruction, major educational vehicles. Educational Researcher, 1974, 3, 7-12.

Williams, J. P. Training kindergarten children to discriminate letter-like forms. American Educational Research Journal, 1969, 6, 501-514.

Willoughby, S. S. Issues in the teaching of mathematics. In E. G. Begle (Ed.), Mathematics Education, 69th Yearbook of the National Society for the Study of Education. Chicago: University of Chicago Press, 1970, 260-281.

TABLE 1

SUMMARY OF RESULTS OBTAINED BY STALLINGS AND KASKOWITZ

| Area | Positive Correlations with Achievement | Negative Correlations with Achievement |
|---|---|---|
| Materials | Textbooks and academic workbooks | Puzzles, games, toys, variety of different materials |
| Activities | Number and reading activities | Arts, crafts, stories, active play |
| Time spent | Time spent in mathematics, reading, and academic verbal interactions | |
| Groupings | Groupings of eight or more pupils with a teacher (grade three) | Children working alone |
| Child questioning | | Child open-ended questions<br>Child nonacademic comments |
| Adult questioning | Adult commands, requests, or direct questions that had an academic focus | Adult nonacademic commands, requests, or direct questions |
| Child responses | Child academic responses<br>Child extended academic responses | Child nonacademic responses<br>Child responses to open-ended questions |
| Adult feedback | All types of adult feedback that had an academic focus (i.e., acknowledgment, praise, positive corrective feedback, negative corrective feedback) | Adult feedback concerning other tasks (e.g., play, music, regardless of type) |
| Child self-instruction | Child self-instruction in academic areas | Child self-instruction in nonacademic areas |
| Conversation | | Child general comments to adults or among children |
| Child behavior | Child task persistence | Child movement<br>Child cooperation with another child |

Source: Stallings and Kaskowitz, *Follow Through Classroom Observation Evaluation*





Rosenshine, 1975

TABLE 2

A Summary of Elements in Direct Instruction

| Elements | Suggested Positive Correlates | Suggested Negative Correlates |
|---|---|---|
| Time and Activities | Time structured by the teacher | Time spent on arts, crafts, dramatic play, active play, stories |
| | Time spent on number and reading activities using textbooks and academic workbooks, or in verbal interactions on reading and mathematics | Gamelike activities |
| | | Number of interactions |
| | | Large number of different, concurrent activities |
| | Time spent in seatwork with academic workbooks through which the pupils proceeded at their own pace | Hours of unstructured time |
| | | Personal socialization |
| Work Groupings | Students worked in groups supervised by the teacher | Free work groups |
| | | Children working independently without supervision of teacher |
| Teacher Directions and Questions | Teacher directs activities without giving pupils choice of activities or reasons for the selection of activities | Teacher joins or participates in pupil's activities |
| | | Teacher organizes learning around pupil's own problem |
| | Learning is organized around questions posed by the teacher | Teacher approaches subject matter in an indirect, informal way |
| | Teacher asks narrow question | Teacher encourages pupil to express himself freely |
| | Teacher asks direct questions that have only a single answer | Teacher permits pupil to suggest additional or alternative answers |



53

Rosenshine, 1975

TABLE 2 (continued)

A Summary of Elements in Direct Instruction

| Elements | Suggested Positive Correlates | Suggested Negative Correlates |
|---|---|---|
| | Adult commands, requests, or direct questions that had an academic focus | Pupil initiates activities |
| | | Pupil has freedom to select activities |
| | | Teacher commands and requests, nonacademic |
| | | Teacher open-ended questions, nonacademic |
| Student Responses | Students give a high percentage of correct answers both in verbal interaction and in workbooks | Child open-ended questions and nonacademic commands |
| | Students are encouraged to attempt to answer questions (rather than saying "I don't know") | Adult nonacademic commands or requests, or open-ended questions |
| | | Child nonacademic responses |
| | | Child general comments to adults or among children |
| Adult Feedback | Teacher immediately reinforces pupil as to right or wrong | Adult feedback on nonacademic activities (e.g., play, music) |
| | Adult feedback had an academic focus | |
| | Teacher asks new question after correct answer | |
| | Teacher gives answer after incorrect answer | |

Sources: Stallings and Kaskowitz, *Follow Through Classroom Observation Evaluation*; Soar, *Follow Through Classroom Process Measurement and Pupil Growth*; Jere E. Brophy and C. M. Evertson, *Process-Product Correlations in the Texas Teacher Effectiveness Study: Final Report* (Austin, Tex.: The University of Texas, 1974).

THE BARRETT TAXONOMY
COGNITIVE AND AFFECTIVE DIMENSIONS
OF
READING COMPREHENSION

1.0 *Literal Comprehension.* Literal comprehension focuses on ideas and information which are *explicitly* stated in the selection. Purposes for reading and teacher's questions designed to elicit responses at this level may range from simple to complex. A simple task in literal comprehension may be the recognition or recall of a single fact or incident. A more complex task might be the recognition or recall of a series of facts or the sequencing of incidents in a reading selection. Purposes and questions at this level may have the following characteristics.

1.1 *Recognition* requires the student to locate or identify ideas or information *explicitly* stated in the reading selection itself or in exercises which use the explicit ideas and information presented in the reading selection. Recognition tasks are:

1.11 *Recognition of Details.* The student is required to locate or identify facts such as the names of characters, the time of the story, or the place of the story.

1.12 *Recognition of Main Ideas.* The student is asked to locate or identify an explicit statement in or from a selection which is a main idea of a paragraph or a larger portion of the selection.

1.13 *Recognition of a Sequence.* The student is required to locate or identify the order of incidents or actions explicitly stated in the selection.

1.14 *Recognition of Comparison.* The student is requested to locate or identify likenesses and differences in characters, times, and places that are explicitly stated in the selection.

1.15 *Recognition of Cause and Effect Relationships.* The student in this instance may be required to locate or identify the explicitly stated reasons for certain happenings or actions in the selection.

1.16 *Recognition of Character Traits.* The student is required to identify or locate explicit statements about a character which helps to point up the type of person he is.

1.2 *Recall* requires the student to produce from memory ideas and information *explicitly* stated in the reading selection. Recall tasks are:

1.21 *Recall of Details.* The student is asked to produce from memory facts such as the names of characters, the time of the story, or the place of the story.

1.22 *Recall of Main Ideas.* The student is required to state a main idea of a paragraph or a larger portion of the selection from memory, when the main idea is explicitly stated in the selection.

1.23 *Recall of a Sequence.* The student is asked to provide from memory the order of incidents or actions explicitly stated in the selection.

1.24 *Recall of Comparisons.* The student is required to call up from memory the likenesses and differences in characters, times, and places that are explicitly stated in the selection.

1.25 *Recall of Cause and Effect Relationship* The student is requested to produce from memory explicitly stated reasons for certain happenings or actions in the selection.

1.26 *Recall of Character Traits.* The student is asked to call up from memory explicit statements about characters which illustrate the type of persons they are.

2.0 ***Reorganization.*** Reorganization requires the student to analyze, synthesize, and/or organize ideas or information explicitly stated in the selection. To produce the desired thought product, the reader may utilize the statements of the author verbatim or he may paraphrase or translate the author's statements. Reorganization tasks are:

2.1 *Classifying.* In this instance the student is required to place people, things, places, and/or events into categories.

2.2 *Outlining.* The student is requested to organize the selection into outline form using direct statements or paraphrased statements from the selection.

2.3 *Summarizing.* The student is asked to condense the selection using direct or paraphrased statements from the selection.

2.4 *Synthesizing.* In this instance, the student is requested to consolidate explicit ideas or information from more than one source.

3.0 *Inferential Comprehension.* Inferential comprehension is demonstrated by the student when he uses the ideas and information explicitly stated in the selection, his intuition, and his personal experience as a basis for conjectures and hypotheses. Inferences drawn by the student may be either convergent or divergent in nature and the student may or may not be asked to verbalize the rationale underlying his inferences. In general, then, inferential comprehension is stimulated by purposes for reading and teachers' questions which demand thinking and imagination that go beyond the printed page.

3.1 *Inferring Supporting Details.* In this instance, the student is asked to conjecture about additional facts the author might have included in the selection which would have made it more informative, interesting, or appealing.

3.2 *Inferring Main Ideas.* The student is required to provide the main idea, general significance, theme, or moral which is not explicitly stated in the selection.

3.3 *Inferring Sequence.* The student, in this case, may be requested to conjecture as to what action or incident might have taken place between two explicitly stated actions or incidents, or he may be asked to hypothesize about what would happen next if the selection had not ended as it did but had been extended.

3.4 *Inferring Comparisons.* The student is required to infer likenesses and differences in characters, times, or places. Such inferential comparisons revolve around ideas such as: "here and there," "then and now," "he and he," "he and she," and "she and she."

3.5 *Inferring Cause and Effect Relationships.* The student is required to hypothesize about the motivations of characters and their interactions with time and place. He may also be required to conjecture as to what caused the author to include certain ideas, words, characterizations, and actions in his writing.

3.6 *Inferring Character Traits.* In this case, the student is asked to hypothesize about the nature of characters on the basis of explicit clues presented in the selection.

3.7 *Predicting Outcomes.* The student is requested to read an initial portion of the selections and on the basis of this reading he is required to conjecture about the outcome of the selection.

3.8 *Interpreting Figurative Language.* The student, in this instance, is asked to infer literal meanings from the author's figurative use of language.

4.0 *Evaluation.* Purposes for reading and teacher's questions, in this instance, require responses by the student which indicate that he

has made an evaluative judgment by comparing ideas presented in the selection with external criteria provided by the teacher, other authorities, or other written sources, or with internal criteria provided by the reader's experiences, knowledge, or values. In essence evaluation deals with judgment and focuses on qualities of accuracy, acceptability, desirability, worth, or probability of occurrence. Evaluative thinking may be demonstrated by asking the student to make the following judgments.

4.1 *Judgments of Reality or Fantasy.* Could this really happen? Such a question calls for a judgment by the reader based on his experience.

4.2 *Judgments of Fact or Opinion.* Does the author provide adequate support for his conclusions. Is the author attempting to sway your thinking? Questions of this type require the student to analyze and evaluate the writing on the basis of the knowledge he has on the subject as well as to analyze and evaluate the intent of the author.

4.3 *Judgments of Adequacy and Validity.* Is the information presented here in keeping with what you have read on the subject in other sources? Questions of this nature call for the reader to compare written sources of information, with an eye toward agreement and disagreement or completeness and incompleteness.

4.4 *Judgments of Appropriateness.* What part of the story best describes the main character? Such a question requires the reader to make a judgment about the relative adequacy of different parts of the selection to answer the question.

4.5 *Judgments of Worth, Desirability and Acceptability.* Was the character right or wrong in what he did? Was his behavior good or bad? Questions of this nature call for judgments based on the reader's moral code or his value system.

5.0 *Appreciation.* Appreciation involves all the previously cited cognitive dimensions of reading, for it deals with the psychological and aesthetic impact of the selection on the reader. Appreciation calls for the student to be emotionally and aesthetically sensitive to the work and to have a reaction to the worth of its psychological and artistic elements. Appreciation includes both the knowledge of and the emotional response to literary techniques, forms, styles, and structures.

5.1 *Emotional Response to the Content.* The student is required to verbalize his feelings about the selection in terms of interest, excitement, boredom, fear, hate, amusement, etc. It is concerned with the emotional impact of the total work on the reader.

5.2 *Identification with Characters or Incidents.* Teachers' questions of this nature will elicit responses from the reader which demonstrate his sensitivity to, sympathy for, and empathy with characters and happenings portrayed by the author.

5.3 *Reactions to the Author's Use of Language.* In this instance the student is required to respond to the author's craftsmanship in terms of the semantic dimensions of the selection, namely, connotations and denotations of words.

5.4 *Imagery.* In this instance, the reader is required to verbalize his feelings with regard to the author's artistic ability to paint word pictures which cause the reader to visualize, smell, taste, hear, or feel.

BASES FOR EVALUATION OF A READER AND RELATED MATERIALS[48]

*Validity:*

1. Is it a realistic expectation that children who have used the book and teaching materials as they were designed to be used will develop power in reading and a desire to read more?
2. Has research preceded or accompanied the development of the reading series to validate its content and methods?
3. Has the evaluation of this program been based either upon actual tryout with pupils or upon the judgment of teachers as to its feasibility?

*Content:*

4. Does the reader present characters with whom the child can identify?
5. Does it reflect American life, leading from the present which the child knows to the past or remote?
6. Does it reflect the best in American and world literature?
7. Does the translation of world literature do justice to the quality of the original?
8. Does it reflect the ideals of the society without being unrealistic?
9. Is it interesting to children of the age group for which it is intended?
10. Does it inform as well as entertain, giving the child a greater self-knowledge and a greater understanding and appreciation of his environment?
11. Do succeeding volumes reflect the expanding world of the growing child?
12. Is there some direct attempt to correlate the readers of the series with the content and goals of the other subject areas of the curriculum?

*Language:*

13. Does the series utilize the basic vocabulary in the language, starting with forms which children hear and use?
14. Does it present the common sentence structures, grammatical structures, and word inflections, beginning with simple, common forms and proceeding to the complex?
15. Does it use the punctuation required by the contents?
16. Does it present words containing letters easy to write and then proceed to more difficult forms?
17. Are new words presented gradually and repeated often enough to assist learning?
18. Are words of multiple meanings presented, with only one meaning given at a time?
19. When one of two common words might have been appropriate in the text, has the choice clearly contributed either to repetition of something learned or to the development of a new learning?
20. Do sentences, paragraphs, and stories increase in length and complexity throughout the books in the series, presenting more and more challenge to established skills?
21. Has some attempt been made to gear this increased length and complexity to the language, interest, and reading ability of the majority of children of the different levels concerned?
22. Is the language in the early books informal and natural without being undesirable?

[48] Paraphrased and quoted from McCullough, *Preparation of Textbooks in the Mother Tongue*, *op. cit.*, pp. 115-18.

23. Have the authors avoided introducing easily confused word forms in the same lesson until each has been well established in previous lessons?

*Physical Aspects:*

24. Is the book suitably durable for the use it is to have?
25. Is its appearance inviting to the reader of the age for which it is intended?
26. Is the paper thick enough not to show print on the reverse side?
27. Is the paper off-white and dull in finish, without glare?
28. Is the print black enough to make a clear contrast with the paper?
29. Is the print large enough for the ocular accommodation of children learning to read?
30. Is the type highly legible, so that letters are not confused with one another?
31. Is the print placed clear of the illustrations?
32. Is the page artistically balanced?
33. Can the child hold the book without covering part of the print?
34. Does the book open flat, so that the child is reading a flat surface?
35. Is the teacher's manual easy to use in relation to the child's book?

*Illustrations:*

36. Is viewing the illustrations an aesthetic experience for the child?
37. Do the illustrations assist in the recognition of words?
38. Do the illustrations help the child determine the identity of the speaker whose words are found in the text?
39. Do the illustrations supplement the text without completely stealing the verbal content (i.e., without making the words superfluous)?
40. Are the illustrations expressive of mood as well as of thought and action?
41. Do the illustrations attract the child by use of color?
42. Do the illustrations emphasize common elements in the culture?

*Teaching Materials:*

43. Do the accompanying materials provide for the assessment of readiness for new learnings?
44. Do they provide exercises for the development of readiness?
45. Do they teach the use of the book (such as the reading of the table of contents)?
46. Do they put the burden of active learning on the child, by such means as: (*a*) asking for picture interpretation, (*b*) asking for generalization and induction, (*c*) asking comprehension questions which require thought rather than finding the place that gives the answer verbatim?
47. Do the teaching materials establish quick recognition of a word at sight as well as the recognition of letters in new words?
48. Are there cards and charts which provide practice in word, phrase, and sentence recognition outside the book itself, so that sheer memorization of pages does not subvert the learning program?
49. Do the teaching materials provide for the assessment of the child's needs and achievement?
50. Do they provide for silent as well as oral reading?
51. Do they provide for skimming exercise ("Find the place that tells. . . .")?

APPENDIX 2 (continued)

51. Do they encourage children to think in many ways about the material they read (*a*) by setting a question before they read and (*b*) by setting questions and related activities after they read?
53. Are there suggestions for children who are slow to learn and for children who learn rapidly?
54. Do writing, speaking, and listening activities support the reading program?
55. Are discussions and other activities suggested for emphasis upon incidental learnings in the content fields?
56. Are the learnings carefully built, one upon another?
57. Is the skills-development program of the first-grade materials as broadly conceived as that for the higher levels (for growth in word form, word meaning, comprehension, interpretation, and study skills)?
58. Are skills taught rather than merely tested?
59. Is the child given opportunities for self-evaluation?
60. Is the teacher guided in how to observe individual child behavior as well as to test for growth?
61. Are the tests broadly conceived, not simply limited to letter pronunciation or word-calling?
62. Are directions to the pupil which he is to read to himself written in words he can understand, and are they expressed clearly?
63. Are directions to the teacher sufficiently simple, clear, detailed, and even, in some cases, illustrated by pictures or diagrams so that the novice can follow them?
64. Are additional teaching aids which are not provided but are suggested or required in connection with activities in the learning program easily and cheaply available wherever the books are likely to be used?

TABLE 1

**Thirteen Reading Programs Analyzed in Terms of Selected Variables**

| | Action-Reading (Allyn and Bacon, 1973) | Alpha One (New Dimensions in Education, 1969) | Breakthrough to Literacy (Bowmar, 1973) | Chicago Psycholinguistic (Chicago Board of Education, 1969) | Color Keys to Reading (Appleton Century Crofts, 1973) Exp. Edition | Holt Basic Reading System (Holt, Rinehart and Winston, 1973) | Listen Look Learn (Educational Developmental Laboratories, 1972) | Miami Linguistic Readers (D. C. Heath, 1970) | Palo Alto Reading Program (Harcourt, Brace & World, 1968) | Reading 360 (Ginn, 1969) | SWRL Beginning Reading Program (SWRL, 1972) | Scott, Foresman Reading Systems (Scott, Foresman, 1971) | Structural Reading Program (Random House, 1973) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COMPONENTS** | | | | | | | | | | | | | |
| Grade levels included | K,1 | 1,2 | K,1,2 | 1 | K,1,2 | K–6 | K–3 | 1,2 | K–3 | K–6 | K–1 | K–8 | K–3 |
| Teacher's guide | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Children's readers | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Programmed texts | | | | | ✓• | | ✓ | | | | | | |
| Workbooks, ditto, etc. | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Audio: records, tape | | ✓ | ✓ | | | ✓ | ✓ | | | ✓ | | | |
| Visual: films, transparencies, charts | ✓ | ✓ | ✓ | | | ✓ | ✓ | | | ✓ | ✓ | | |
| Supplementary books (literature) | | | T | | | ✓ | ✓ | | | ✓ | | ✓ | T |
| Teacher-training kits | | | | | | | | | | | ✓ | | |
| Tutoring program | | | | | | | | | | | ✓ | | |
| Behavioral objectives and/or criterion measures | ✓ | ✓ | | | | ✓ | ✓• | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Tests (placement, diagnostic, summative) | | Sum | | | Sum,Pl | Pl,Sum, Diag | Sum | Pl,Sum | Sum | Pl,Sum, Diag | Pl,Sum, Diag | Pl,Sum | |
| **READER CONTENT** | | | | | | | | | | | | | |
| Selections | | | | | | | | | | | | | |
| From literature | | | | | | ✓ | ✓ | | | ✓ | | ✓ | ✓ |
| Created for readers | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Lifestyle and values portrayed | | | | | | | | | | | | | |
| White, black, Hispanic, Indian, mixed | | | Wh | Bl | Mix | Mix | Mix | Mix | Wh/Mix | Mix | None | Mix | Mix |
| Urban, suburban, rural, mixed | | | Sub | Urb/Sub | Mix | Mix | Mix | | Sub | Mix | | Mix | Mix |
| Low SES, mid SES, hi SES, mixed | | | Mid | Mid | Mix | Mix | Mix | | Mid | Mix | | Mix | Mix |
| Child-centered, community, nature, fantasy | | Ch,Fan | Ch | Ch | Ch | Mix | Ch | Mix | Ch,Na | Mix | Fan | Mix | Mix |
| Illustrations | | | | | | | | | | | | | |
| None, relevant, general | | Rel | Rel | Rel | Rel | Rel | Rel | Rel | Rel | Rel | Rel | Rel | Rel |
| Vocabulary control | | | | | | | | | | | | | |
| Meaningfulness/frequency | | | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓• | |
| Phonic regularity (grapheme/phoneme) | ✓ | ✓• | | | ✓ | | | ✓ | ✓• | | ✓• | | ✓ |
| Word patterns | ✓ | | | | | | | ✓• | ✓• | | ✓• | | ✓ |
| **WORD ATTACK SKILLS FOR EARLIEST READERS** | | | | | | | | | | | | | |
| Isolated letter/sound | ✓ | ✓• | T | | ✓ | | | | ✓ | | ✓• | | |
| Word patterns | ✓ | | | | | ✓ | ✓ | ✓• | ✓ | ✓ | ✓• | | ✓• |
| Individual words | ✓ | | ✓ | ✓ | | ✓ | ✓• | ✓ | | ✓• | ✓ | ✓ | |
| Blending sounds into words (synthetic) | ✓ | ✓ | T | | ✓ | | | | ✓• | | ✓• | | ✓ |
| Abstracting letters/sounds from words (analytic) | ✓ | | T | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Direction emphasized in introducing elements | | | | | | | | | | | | | |
| Symbol to sound | | ✓ | | | | | | | | | ✓ | ✓ | |
| Sound to symbol(s) | ✓• | | ✓• | ✓ | ✓• | ✓ | ✓• | ✓• | ✓• | ✓ | | | ✓ |
| Set for "diversity" or "regularity" | Reg | Reg | Div | Div | Div | Div | Div | Reg | Reg | Div | Reg | Div | Reg |

TABLE 1 (Cont.)

| | Action-Reading (Allyn and Bacon, 1973) | Alpha One (New Dimensions in Education, 1969) | Breakthrough to Literacy (Bowmar, 1973) | Chicago Psycholinguistic (Chicago Board of Education, 1966) | Color Keys to Reading (Appleton Century Crofts, 1973) Exp. Edition | Holt Basic Reading System (Holt, Rinehart and Winston, 1973) | Listen Look Learn (Educational Developmental Laboratories, 1972) | Miami Linguistic Readers (D. C. Heath, 1970) | Palo Alto Reading Program (Harcourt, Brace & World, 1968) | Reading 360 (Ginn, 1969) | SWRL Beginning Reading Program (SWRL, 1972) | Scott, Foresman Reading Systems (Scott, Foresman, 1971) | Structural Reading Program (Random House, 1972) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Other cues | | | | | | | | | | | | | |
| Diacritics, color, other | Objects | People/ letters Pic | Txt&Pic | Txt&Pi | Color Txt&Pic | Txt&Pic | Txt&Pic | Txt&Pic | Txt&Pic | Txt&Pic | Txt&Pic | Txt&Pic | Txt&Pic |
| Contextual: text or pictures | | | | | | | | | | | | | |
| **INITIAL EMPHASIS** | | | | | | | | | | | | | |
| Comprehension | ✓ | | ✓• | ✓ | ✓ | ✓• | ✓ | | ✓ | ✓ | | ✓• | ✓ |
| Decoding | ✓• | ✓ | ✓ | | | ✓ | | ✓• | ✓• | ✓ | ✓ | | ✓ |
| Writing | | ✓ | ✓• | | | ✓ | ✓ | ✓ | ✓• | | | | ✓ |
| Communication (language arts) | | | ✓• | ✓ | | | ✓ | | | | | ✓ | |
| **PACE** | | | | | | | | | | | | | |
| Rapid, moderate, slow, flexible | Rapid | Slo | Flex | Mod | Rapid | Mod/Rap | Flex | Mod | Mod | Mod | Slo | Mod | Mod |
| Controlled by teacher or child | Tchr | Tchr | Ch | Tchr | Tchr | Tchr | Both | Tchr | Tchr | Tchr | Tchr | Tchr | Tchr |
| **CHILD's BEHAVIOR** | | | | | | | | | | | | | |
| Discussion | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |
| Listening activities | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓• | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Oral reading in readers | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |
| Silent reading in readers | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Answering questions | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Spelling | ✓ | ✓ | ✓ | | ✓ | | | ✓ | ✓ | | | | ✓ |
| Learns phonic relationships | ✓ | ✓ | | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Writing | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | | | | ✓ |
| **TEACHER's ROLE** | | | | | | | | | | | | | |
| Introduces new elements (words/letters) | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Reads daily with children | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Follows routine of guide (for selections) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Cognitive level of questions in teacher's guide | | | | | | | | | | | | | |
| Recall | ✓ | ✓ | | ✓ | | ✓ | ✓ | ✓• | ✓ | ✓ | ✓ | ✓ | |
| Problem solving | | ✓ | | ✓ | | ✓ | | ✓• | | | | ✓ | |
| Creating ideas | | | ✓ | ✓ | | ✓ | | | | | | ✓ | |
| Evaluative | | ✓ | | | | ✓ | ✓ | | | ✓ | | ✓ | |
| Optional (teacher decision) | | | ✓ | | • | | | | | | | | ✓ |
| **PARENT INVOLVEMENT** | ✓• | ✓ | | | | | | | | | ✓ | ✓ | |

✓ = Variable is present to a significant degree.
✓• = Variable is emphasized.
T = Teacher's option.
– = Variable is not emphasized.
• Workbooks in Color Keys are semiprogrammed.
† A statement of skills taught is also included in this category.
‡ Animal characters are used throughout.

SOURCE: Adapted from Chall (1967, p. 337).

REPORT OF THE WORKING GROUP ON GOALS FOR

BASIC MATHEMATICAL SKILLS AND LEARNING

Volume II Working Group Reports

The NIE Conference on Basic Mathematical

Skills and Learning

Euclid, Ohio, 1975

## General Goals

The purpose of mathematics education is threefold: (1) to prepare the child for life as a consumer, voter, and citizen; (2) to begin the training for a variety of productive occupations and professions; and (3) to assist the child in developing a rich and rewarding life.

Broadly, then, school mathematics should develop a student's ability to think. In suitable contexts, experience with mathematics can enhance a student's perceptions, help him or her reason constructively, and bring insight to a wide variety of problems and situations. In many situations the contributions of experiences in learning mathematics to one's ability to think are vital to the attainment of a goal or solution of a problem.

Second, education in mathematics should encourage the ability to feel secure in situations calling for reasoning or quantitative thinking. The student should develop the level of self-confidence necessary to operate effectively in a society that makes heavy use of mathematics and mathematical ideas.

Third, mathematics should improve students' ability to do. Mathematics education should include a range of "mathematical tools" useful in practical contexts. These tools help people cope with realistic problems in efficient ways.

## Basic Goals

### Appropriate Computational Skills

The automation of arithmetic during the past half century has strongly affected educational needs. Hand-held calculators have had the most recent

(and potentially drastic) effects. The whole issue of the effect of the calculator on the teaching of arithmetic is a very complex one which deserves considerable investigation and consideration. As a rule, decisions on arithmetic topics should consider both general usefulness to adults in the coming decades and the investment of time that a majority of students need for mastery.

With the increasing availability of calculators, adults will have less need for longhand arithmetic in the future. The time that we currently spend teaching elaborate long division problems and complicated lowest common denomination fraction problems -- often with little success -- could be better spent on more interesting, rewarding, and motivating topics.

However, students should not become completely dependent on calculators. While avoiding endless and mindless drill in computation, we should emphasize the mathematical principles and concepts underlying the computation algorithms. For example, the two-by-one digit multiplication algorithm depends on distributivity. Learning the processes of computation combined with the skills of estimation and approximation is useful in terms of readiness for future learning.

We must find the "right" combination of understandings and skills to enable a student to develop an algorithm when necessary and to use the mechanical and electronic devices when it is efficient to do so. Students must know the basic single-digit number facts, including the multiplication table, and should be fluent at some relatively simple types of computation. Exactly how much, between this "bare bones" minimum and the amount of computation that is currently being taught, is a question that needs further study and far more discussion among a broader base of people.

Links Between Mathematical Ideas and Physical Situations

Students should be able to relate the abstract properties of mathematics to physical situations. This typically involves expressing a real situation in mathematical terms, manipulating the mathematics with an eye to gaining some conclusions about and insight into the real situation, and then translating the result back into realistic terms. When coupled closely with the teaching of mathematical skills and ideas, these relationships can help enhance motivation, provide mental frameworks on which to hang more abstract ideas, and offer ways for students to stay in practice. (The basic goals which follow are closely related to this one.)

Estimation and Approximation

These skills are basic to facility and comfort with quantitative ideas. Students should know some simple techniques for estimating quantity, length, distance, weight, and so on. Also, students should be able to carry out approximate, rapid calculations by first rounding off numbers. Necessary here are a sense of the likely error in various procedures, and of whether a particular result is precise enough for the purpose at hand.

Organization and Interpretation of Numerical Data, Including Using Graphs

Currently, information often takes the form of numbers -- sometimes many numbers at once. Students should know not only how to set up simple tables, charts, and graphs, but also how to read them and draw conclusions. Well-organized charts and graphs are especially helpful in recognizing patterns and trends in a collection of numbers. Moreover, students should be confident enough with numerical data that a mass of numbers per se is not intimidating.

Measurement, Including Selection of Relevant Attributes, Selection of Degree of Precision, Selection of Appropriate Instrument, Techniques of Using Measuring Instruments, and Techniques of Conversion Among Units Within a System

Measurement is central to useful mathematics because measurement is the way people most often express reality in numbers. While it is possible to argue whether measurement is more legitimately a topic of mathematics or of science, no one will dispute its importance. At a minimum, students should know how to measure length, distance, weight, volume, and temperature, and perhaps area and angles as well.

Alertness to Reasonableness of Results

Due to arithmetic errors or other mistakes, results of mathematical work are sometimes wrong. Occasionally they are manifestly unsound. Students should learn to inspect all results, checking for reasonableness in terms of the original problem.

Qualitative Understanding of and Drawing Inferences from Functions and Rates of Change

This refers to a general understanding of how one quantity can "depend" on another, along with a qualitative grasp of rates of change. For example, one's financial condition can be projected on the basis of present condition, rate of expenditure, and rate of income. Graphs and tables can be used to give students a feeling for relationships among quantities.

Notions of Probability

Students should learn enough about probability to be able to meaningfully interpret weather forecasts and other predictions that are presented using notions of probability. Students should be able to rationally apply probability in problem-solving and gambling situations. For example, they should be aware of the notion of independence of events, realizing, for instance, that if a fair coin is flipped the probability of heads is 1/2 regardless of what occurred on previous flips.

## Computer Uses: Capabilities and Limitations (Gained through Direct Experience)

It is important for all citizens to understand just what computers do -- and do not do. The "mystique" surrounding computers is disturbing, for it can put people with no understanding of computers at a disadvantage. By far, the best way to become acquainted with computers is to work with them, even if only a little. To gain a sense of what computers do best, and of how much their performance is governed by human planners and programers, there is no substitute for writing, debugging, and running a simple program. A little experience can go a long way toward dispelling the computer mystique.

## Problem Solving

Problem solving should be considered as a special goal interrelated with all of the general, basic, and further desirable goals presented here. For example, for computation to be useful, we must be able to determine when to add, subtract, multiply, or divide. Basic goals such as estimation and approximation, organization and interpretation of data including the use of graphs, and alertness to reasonableness of results are important primarily because of the contributions they make to problem solving. Everyone should have a large collection of facts, information, and experiences that can be helpful when confronting a new situation. Changing scale, or changing frame of reference, can make the problem look different, and sometimes easier. Successive approximation can help narrow the problem to a workable solution. There are many other examples of general problem-solving techniques.

# Further Desirable Goals

## Recognition that Mathematics is a Construct

Mathematics is a product of creative and inquiring minds. It is a live and dynamic discipline with new developments that are stimulated both by practical and theoretical sources. The basic goals previously listed tend to stress relations between the mathematical realm and the real world. However, students should know something about internal considerations of the discipline of mathematics. While mathematicians have great freedom in selecting assumptions upon which mathematics is based, they must develop mathematical structures that are internally consistent. In some cases, such as the development of non-Euclidean geometries, the assumptions selected may appear to be implausible. However, mathematicians do not tend to select their assumptions capriciously. Their work is directed toward contributing to theoretical mathematical knowledge or practical application of mathematics.

## Ability to Reason Abstractly

Students should be able to reason in the abstract realm without recourse to the concrete. Students should come to understand the nature of an argument or proof, and should be able to form an opinion about its reasonableness. The ability to construct such arguments, in purely abstract ways, is useful in other fields as well as in mathematics.

## Enrichment of the Student's World

Mathematics can be an aid to insight -- a way of looking at events and phenomena that brings increased appreciation, understanding, and creativity. Developing such styles of perception is, or should be, part of what it means to become educated. A student's world can be enriched by gaining knowledge of the contributions that mathematics (and mathematicians) have made to our culture.

## Acquaintance with the Natural Notations of Mathematics

Over the centuries, people have worked out certain ways of writing down mathematical ideas. In the process, an international written language has been developed for communicating mathematical ideas. The use of exponents and the development of Hindu-Arabic notation, including the use of the numeral zero, are examples of notations that have facilitated mathematical communication and thought.

## Mathematical Modeling

A mathematical model represents, in the abstract realm, certain aspects of some real or hypothetical situation. Its power stems from the relative ease of manipulating the mathematics instead of the real situation. For example, a mathematical model could be created by making mathematical assumptions concerning the size of the whale population in the world and factors affecting birth and death rates of whales. Then the model could be used to predict the growth or decline of the whale population.

The principle of mathematical modeling has been an important element in human progress over the past few hundred years. It is through models that mathematics finds some of its most elegant and useful applications to the changing needs of mankind.